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OFFICE OF MANNED SPACE FLIGHT

PROGRAM DIRECTIVE

(NASA-CR-118606) APOLLO SYSTEM TEST PLAN DOCUMENT. PART 1 APOLLO SYSTEM TEST PLAN REQUIREMENTS. PART 2 - APOLLO SYSTEM TEST PLANS /TO BE SUPPLIED (National Aeronautics and Space Administration) 109 p

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(DRAFT)

APOLLO SYSTEM TEST PLAN DOCUMENT (U)

PART 1 - APOLLO SYSTEM TEST PLAN REQUIREMENTS

PART 2 - APOLLO SYSTEM TEST PLANS (TO BE SUPPLIED)

MAY 17 1963

MAY 17 1963

GROUP ... Downgraded at 3 year intervals; ... classified after 12 years.

NASA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C.

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PROGRAM REQUIREMENT DOCUMENT

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M-D E 8000.009

(DRAFT)

APOLLO SYSTEM TEST PLAN

DOCUMENT (U)

Date Effective:

_____

Office of Manned Space Flight
National Aeronautics & Space Administration
Washington 25, D. C.

APOLLO SYSTEM TEST PLAN DOCUMENT

PREFACE

PURPOSE:

The purpose of the Apollo System Test Plan Document is to:

a. Set forth minimum test requirements and test plan requirements to provide a basis for implementing the Apollo test program.

b. Provide a single consolidated test plan document for analyzing and evaluating the test program to determine the potentiality of mission accomplishment.

CONTENT: Reference following chart.

PART 1 - Apollo System Test Plan Requirements:

a. Minimum test requirements for ground and flight tests

b. Minimum test plan requirements for ground and flight tests

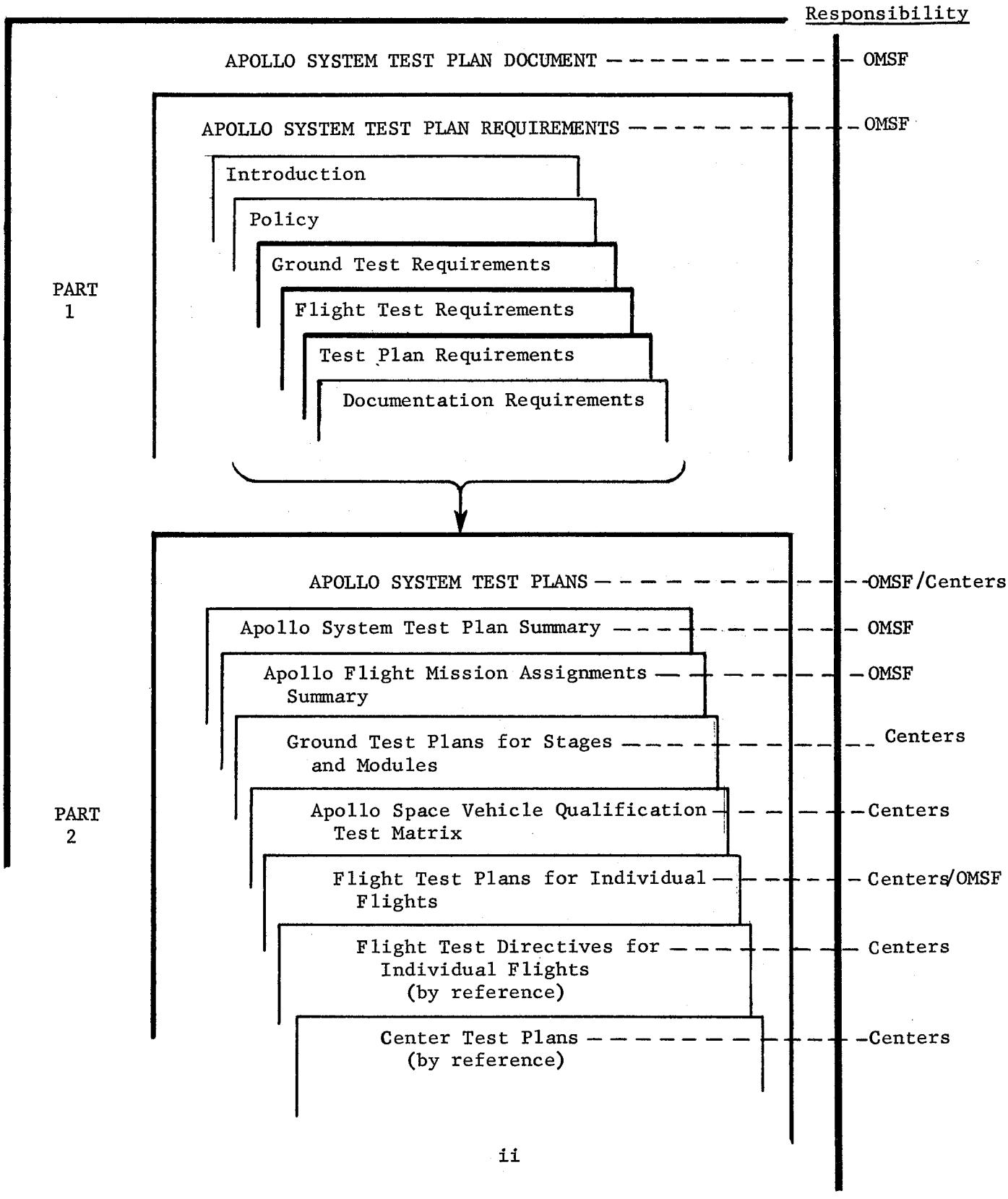
PART 2 - Apollo System Test Plans:

Compilation of test plans, either by inclusion or reference, which are

(1) In existence, or

(2) To be developed

APOLLO SYSTEM TEST PLAN



PART 1

APOLLO SYSTEM

TEST PLAN REQUIREMENTS

PART 2 APOLLO SYSTEM TEST PLANS

Will be Completed Based on PART 1 Above.

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To be supplied.

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To be supplied.

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To be supplied.

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REFERENCE DOCUMENTS

OMSF DOCUMENTS:

1. Apollo System Specification.
   (to be issued).

2. Apollo Flight Mission Assignments Summary, dated April 9, 1963
   (M-DE 8000.005A).

3. Natural Environment and Physical Standards Specification
   (M-DE 8020.008), (to be issued).

4. Office of Manned Space Flight Reliability Plan
   (under preparation).

5. Apollo Mass Properties Standard (M-DE 8000.006)
   (to be issued).

6. Manned Space Flight Schedules:

   a. OMSF Instructions M-IM 9330.002, dated December 5, 1962.

   b. OMSF Instructions M-IM 9330.003, dated January 2, 1963.

OTHER NASA DOCUMENTS:

1. NASA Quality Publication NPC 200-1, dated April 1962
   Quality Assurance Provisions for Inspection Agencies.

2. NASA Quality Publication NPC 200-2, dated April 1962
   Quality Program Provisions for Space System Contractors.

3. NASA Quality Publication NPC 200-3, dated April 1962
   Inspection System Provisions for Suppliers of Space Materials,
   Parts, Components, and Services.

4. NASA Reliability Publication NPC 250-1, dated March 13, 1963.
   Reliability Program Provisions for Space System Contractors.

PART 1

APOLLO SYSTEM TEST PLAN REQUIREMENTS

I. INTRODUCTION

A. Purpose

The purpose of this document is to establish for the Apollo System:

1. The minimum test requirements
2. The minimum test plan requirements

B. Prime Objectives

The prime objectives are the establishment of:

1. An Integrated Apollo System Test Plan (Part II) for the Apollo/Saturn *space vehicles and their associated *ground support systems.
2. Compatible test philosophies, policies, practices, and terminologies for the various elements of the Apollo System.
3. A standard for analyzing and evaluating the potentiality of accomplishment of the Apollo *mission in accordance with prescribed schedules.

C. Scope

This document is applicable to the following programs:

1. Apollo/Little Joe II
2. Apollo/Saturn I
3. Apollo/Saturn IB
4. Apollo/Saturn V
5. Other Apollo programs

*For Definition
See Appendix A

I. INTRODUCTION (Continued)

D. Applicability to Subsidiary Test Documents

The requirements established in this document shall be fully reflected in subsidiary Apollo test documents such as Test Plans, Test Specifications, and Test Procedures and in related contractor scopes of work.

E. Revisions and Waivers

Revisions of this document (initial issue) will be published by OMSF when deemed appropriate.

Procedures for approving deviations from the requirements established in this document shall be in acccordance with an OMSF Directive to be issued.

To be augmented.

F. Definition of Terms

There are numerous terms utilized in this document which require definition in order to clearly delineate requirements. Terms which have gained common usage in the Apollo Program are utilized insofar as possible.

Definitions of terms are contained in Appendix A. Each term used in this document which is defined in Appendix A is denoted by an asterisk.

G. Draft Issue

The draft of this document is not complete. The necessity for expansion of material submitted, or for submission of complete paragraphs at a future time is indicated as applicable. Changes will be made to this draft as appropriate, based on reviews with the Centers.

*For Definition,
See Appendix A

II. APOLLO SYSTEM TEST POLICY

A. General

This document supplements the Apollo program concepts and defines the minimum ground and flight test requirements for the Apollo mission.

The Apollo test program is a key factor in assuring the successful accomplishment of the Apollo* mission.

B. Center Review and Control of Contractor Test Activities

As an adjunct to the test program contained herein to further assure and augment the development of the required operational hardware, the Centers shall monitor and control the contractor's test activities. To accomplish this, the Centers may select (on a random or planned basis) hardware produced by the contractor and subject same to verification and inspection tests deemed necessary to evaluate the performance of the contractor.

All tests shall be performed, supervised, or reviewed by the Center personnel.

*For Definition,
See Appendix A

II. APOLLO SYSTEM TEST POLICY (Continued)

C. Test Requirements Versus Program Limitations

It is recognized that there are limitations on funds and time which in many cases tend to be overriding factors in the planning of test programs.

The minimum test requirements which are essential to the accomplishment of the Apollo* mission are set forth herein.

D. Engineering Confidence Levels Versus Statistical Confidence Levels

Limited funds and accelerated schedules will not generally allow performance of tests on a number of samples which have statistical significance. Consequently, it is mandatory that the best engineering judgment be applied in the design of tests and in the analysis and evaluation of the test data, in order that the highest degree of engineering confidence will result. The statistical approach will be used as a tool where feasible.

The overall test program will be designed to yield the maximum amount of correlated data for use in establishing the highest degree of engineering confidence (using statistical approach as an aid to the degree feasible).

*For Definition,
See Appendix A

There will be certain *assemblies and other lower levels of hardware so vital to the safety of the crew or the completion of the mission that statistical numbers of samples must be tested. Also, the state-of-the-art or uncertainty associated with certain hardware will require larger numbers of test *samples and more extensive testing in depth.

E. *Qualification Tests

As a general policy, all systems must successfully complete:

1. A *ground qualification test prior to unmanned flight test
2. A *flight qualification test prior to manned flight test

F. Basic Test Types and their Relationship to Each Other

In order to enhance communications and clearly delineate the tests required in this document, the basic test types which will be utilized in the Apollo program are defined in Sections III and IV below. Although it is recognized that there is varied test type terminology now being employed in the Apollo program, the new basic test type terminology will be adopted in the future. The numerous tests defined by varied terminology shall be categorized in the Apollo System Test Plan into the basic types prescribed by this document. The relationship of basic test types to each other is shown in Figure No. 1.

III. GROUND TEST REQUIREMENTS

A. General Objectives

Ground tests shall be utilized to the maximum practicable extent in demonstrating operational suitability of and establishing engineering

*For Definition, See Appendix A

FIGURE NO. 1

RELATIONSHIP OF BASIC TEST TYPES TO EACH OTHER

To be supplied.

confidence in space vehicle systems. The prime objectives of ground tests are as follows:

1. Evaluation of new materials, processes and systems in support of design development efforts on the Apollo System.
2. Demonstration of design adequacy.
3. Verification that hardware fulfills design and quality requirements.
4. Establishment of engineering confidence that hardware will perform adequately during flight and furnish data for *reliability assessment.
5. Discovery of hardware deficiencies in sufficient time to allow corrective action prior to delivery of *flight hardware from the contractor's plant.
6. Minimize number of flight tests required.
7. Minimize time and cost of reaching *operational status.

B. General Requirements

If there is any conflict between these general requirements and specific requirements set forth in this document, the specific requirements will have precedence.

1. Determination of Relative Merits in Combining Test Types into one Test (Hybrid Type)

The objectives of several test types may be combined into one test. This is particularly true at the *stage, *module, *launch vehicle, *spacecraft, or *space vehicle levels.

*For Definition, See Appendix A.

2. Priorities (Relative Merits) of Test Types

In the event that the specific requirements of this document cannot be met, proposals for waivers shall be requested in accordance with following:

a. *Qualification tests will be given priority over *reliability tests.

b. Qualification tests for higher hardware generation levels will be given priority over lower *hardware generation levels, such as *assemblies over *piece parts.

c. *Limited qualification test - where *environments cannot be adequately simulated at one generation level (*stages, for example), additional emphasis will be given to environmental testing at the next lower generation level.

d. The *criticality of hardware shall be the basis for establishment of test priorities; i.e., the amount of

*For Definition, See Appendix A

testing shall be apportioned such that more testing is allocated to the most critical items.

The Centers shall develop a failure effects analysis system for establishing *criticality classifications in accordance with *hardware criticality categories listed in Table No. 1.

3. Test Types Versus Generation Levels of Hardware

Tests will be planned with due consideration given to tests at various generation levels of hardware, such as *piece parts or *components, *assemblies, *subsystems, *stage or *module, *launch vehicle, *spacecraft, and *space vehicle.

Particular emphasis shall be given to interactions at higher generation levels which are not seen at lower generation levels.

For example, the qualification of a *component does not necessarily mean that it will work properly when exposed to a resonant frequency or overheated condition in an *assembly.

4. Use of Computers for Simulating Closed Loops

To be supplied.

*For Definition, See Appendix A

5. Requirement for Test Under Reasonable Facsimile of Actual Mission Environments

Test plans shall specify the operational environments including actual combinations and sequences of stresses for all parts, *components, *assemblies, *subsystems and *systems. This shall include establishment of *safety factors for environmental stresses for all elements of the system throughout the *mission spectrum.

C. *Design Development Tests

1. Definition:

*Design development tests are ground tests performed to establish the design of hardware suitable for flight operations. They may be employed to determine feasibility of approach, usability of *standard hardware, or for evaluation of performance of hardware and techniques under simulated or actual environmental conditions. They may be employed to make an engineering evaluation of *safety factors or *safety margins and *failure modes. These tests are performed on developmental hardware which is representative of, but not necessarily identical to, the *flight hardware.

2. Minimization of Tests by Part and *Component Selection

To be supplied.

*For Definition,
See Appendix A

3. Requirements for *Design Development Tests

The Centers shall determine what *design development tests are required. *Design development tests at the *stage and *module level shall be in accordance with the Ground Test Plans for Individual Stages and Modules (see paragraph V.B.3).

The Centers shall determine when the hardware design has progressed to the degree that *ground qualification tests may commence.

D. *Ground Qualification Tests for Flight Type Hardware

1. Definition:

*Ground qualification tests are *functional tests performed on *flight type hardware (samples which are identical to *flight hardware in design and fabrication) at levels of environments equal to or slightly above the flight environmental levels (predicted or actual) in order to verify that hardware is ready for flight. Usually, small numbers are tested.

In order to constitute "*qualification," a successful completion of *qualification tests on all units of the *sample without *failure is required (subject to the following paragraph).

2. *Failure Disqualifies Entire *Class of Hardware

Any *failure of a test specimen shall disqualify the entire *class of hardware being subjected to qualification tests. Where a *failure occurs, hardware and/or procedural change(s) shall be introduced into the entire *sample and all units of the *sample shall be requalified. However, if the cause of *failure is a quality defect which can be detected by a nondestructive inspection, then those units of the

*For Definition,
See Appendix A

*sample which have already been tested without *failure need not be retested. Nevertheless, all units must perform without *failure, including the retested units for which defects have been corrected. In the above cases, extreme caution shall be taken to assure that these changes and corrections are made to all units in the *class, and that such action will not degrade the units.

Where the *failure of an item of hardware can be traced to a lower *generation level (such as a propellant pump during an engine test), and the condition(s) of *failure (such as environmental levels or functional interactions) can be clearly defined, then a requalification program on the propellant pump will be sufficient and all *qualification or PFRT engines do not necessarily have to be retested with the modified pumps. If the functional interactions or environmental levels causing the *failure cannot be isolated or defined, then all items of hardware must be requalified.

Further, immediate corrective action (design, fabrication and/or inspection) shall be initiated to prevent recurrence of quality defect

3. <u>*Simulated Environment</u>

Where feasible, combinations of environments shall be programmed in a manner that would approximate or exceed the actual flight conditions.

When planning tests, particular emphasis shall be given to the most adverse environments for the specific hardware.

*For Definition,
See Appendix A

4. Hardware for Qualification Testing

a. Prerequisites to Qualification Tests

*Production tests shall be performed on hardware prior to its being subjected to *ground qualification tests. Up to the specific level of assembly applicable, the *production tests shall be identical to the *production tests performed on the *flight or *ground support system hardware.

In addition to *production testing, additional *functional test time shall be accumulated on the test specimen which is representative of the functional life cycle to be encountered.

b. Control of Hardware and Procedures

Qualification tests shall be performed on *flight type hardware.

Revisions to procedures, changes to hardware, or adjustments or tuning of hardware shall not be permitted during the course of the *qualification test on the specific unit, unless required during normal operation.

Hardware that has been subjected to *ground qualification tests shall not be utilized on flight vehicles.

5. Man-Machine Qualification

Particular emphasis shall be given to qualifying the man-machine compatibility and adequacy for performing the operational aspects of the *mission, such as compatibility of flight crew with life support equipment, human factors of controls and displays and crew safety under simulated *mission environments.

*For Definition,
See Appendix A

6. *Qualification Test Requirements

a. *Ground qualification tests shall be performed on *flight type hardware in accordance with Table No. 2, page 28. (See Table No. 1 for hardware criticality categories.)

b. All *ground support systems shall be qualified.

c. The Centers shall determine the number of units (*sample size) for each *class of hardware to be tested.

7. Requalification Test Requirements

Centers shall establish a program for assuring that requalification of hardware will be initiated where appropriate, including:

a. When modifications which affect functioning or reliability have been made.

b. Where inspections, tests, and/or flight data indicate that a more severe environment and/or operational condition exists than that to which the equipment was originally tested.

8. Qualification Tests for *Ground Support Systems

To be supplied.

*For Definition,
See Appendix A

E. Ground *Reliability Tests for Flight Type Hardware

1. Definition:

Ground *reliability tests are those tests whose prime purpose is to assess probability of *mission success. These tests utilize *sample sizes which have statistical significance.

*Reliability assessment data may be obtained from results of other test types.

*For Definition, See Appendix A

2. Environmental Test Levels

Where test-to-failure is planned, prime emphasis shall be placed on time. That is, the elevating of environmental rigors (stresses) beyond those predicted or measured in flight should be kept to a minimum consistent with the uncertainty of the environment to be encountered in flight and the *failure scatterband for the hardware. Otherwise, the *reliability will be determined at a level of environment under which the hardware will never operate.

3. Prerequisites for Hardware to be Utilized

*Ground qualification tests shall be performed on a *sample of a *class of hardware prior to its being subjected to ground *reliability tests. *Reliability tests may be a continuation from *qualification test. The purpose is to assure correlation with other test data and to give reasonable assurance that hardware meets specifications prior to initiating more extensive testing. Hardware utilized for ground *qualification of hardware under paragraph III.D above should be used for ground *reliability testing where feasible.

4. Control of Hardware and Procedures

*Reliability tests shall be performed on *production hardware under the strictest control of environments and procedures. No revision to procedures, changes to hardware, or adjustments or tuning of hardware is permissible during the course of the test.

*For Definition, See Appendix A

5. Ground *Reliability Test Requirements

Ground *reliability test requirements shall be performed in accordance with Table No. 2. These requirements are based on *hardware criticality categories shown in Table No. 1

The Centers shall determine the numbers of *samples to be tested, the levels of environments, the durations of testing, and other specific characteristics of the tests in accordance with requirements stated herein.

F. Specific Ground Tests

1. Dynamic Tests

a. Definition

*Dynamic tests are performed on *stages, *modules, and combinations thereof, which are representative of the flight configuration.

The tests are performed under conditions simulating the dynamic flight environments.

*For Definition,
See Appendix A

b. Requirements

Because of the "multi stage" influence, *dynamic tests shall first be performed on individual test stages (instrument unit and *modules) to establish dynamic structural characteristics. The test vehicles will then be mated, and a *dynamic test of the *space vehicle shall be performed to determine as nearly as possible: the structural characteristics under simulated flight dynamic conditions to establish vehicle structural resonant characteristics, bending mode shapes, and damping characteristics.

Other objectives of the *dynamic tests shall be:

(1) Determination of mating compatibility of vehicles

(2) Comparison of *dynamic test results with subsequent flight test results for continuous development of the *dynamic test techniques and facilities, to assure the highest possible degree of accuracy in development and qualification of vehicle structure prior to flight.

Any significant structurally-related design change, as determined by t Centers, in any of the *stages or *modules requires that a *dynamic test be performed on a test vehicle representing the modified configuration

2. System Compatibility Tests

To be supplied.

*For Definition, See Appendix A

3. Structural Tests

To be supplied.

4. *All Systems Tests

To be supplied.

5. *Battleship Tests

To be supplied.

6. Environmental Tests (Thermal, Acoustic, Vibration)

To be supplied.

7. Recovery Tests (Water, Land)

To be supplied.

8. Combined Systems Tests

To be supplied.

9. Impact Tests (Water, Land)

To be supplied.

10. House Tests

To be supplied.

11. Hover and Landing Tests

To be supplied.

12. Preliminary Flight Rating Test for Rocket Engines

To be supplied.

*For Definition, See Appendix A

III. GROUND TEST REQUIREMENTS (Continued)

G. *Production Tests

1. General Definition:

*Production tests are conducted on all fabricated or procured hardware prior to, during or at the completion of assembly or manufacture for the purpose of determining whether the performance, tolerances, and quality are within specified limits.

2. *Production Test Types - Definitions and Requirements

a. *Screening Tests

*Screening tests are tests which employ environmental, electrical, and mechanical stresses, separately or in combination, to identify abnormal individual component parts by their responses. Such tests impose a requirement for normality for survival and identify potentially weak individual parts, thereby precluding their installation in equipment. *Screening tests usually yield immediately useful results. They must be nondestructive in the sense that they must not degrade performance or significantly reduce the life expectancy of "normal" parts.

*Screening tests shall be performed in accordance with Table No. 3.

b. *Acceptance Tests

An *acceptance test is defined as any test performed at any level of assembly (such as *piece part, *component, *assembly,

*For Definition, See Appendix A

*subsystem, *stage or *module, or *ground support systems) for the purpose of demonstrating its compliance with procurement specifications and its functional acceptability. This test shall be performed under the surveillance of the customer prior to transfer of ownership of the item.

(1) *Receiving Tests

Receiving tests are defined as *nondestructive functional tests performed on parts, *components, or *assemblies, when received at assembly facility.

These tests shall be performed on 100% of the functional (operating) items in accordance with Table No. 3.

For receiving inspection, see NPC 200 series.

(2) *In-Process Tests

*In-process tests are defined as all production line tests performed at intermediate points between *receiving tests and start of final manufacturing checkout.

As a minimum requirement, *in-process tests shall be performed at all points of assembly where further assembly will reduce the capability of a complete *functional test of the specific unit (see Table No. 3).

*For Definition, See Appendix A

(3) Manufacturing Checkout

This test is the "final"* acceptance test at a manufacturer's plant and is performed primarily for the purpose of assuring as a minimum the following:

(a) Manufactured in accordance with design* documentation.

(b) Functions in accordance with design intent.

(c) Mates properly with other items - physically and functionally.

(d) Mates properly with items of* ground support systems - physically and functionally.

*Stage, instrument unit and *module requirements for manufacturing checkout shall be in accordance with Table No. 3.

(4) *Acceptance Test Firing of *Stages and *Modules

This type of test firing is defined as a captive firing of a flight *stage or *module for the purpose of verifying the performance of all systems under environments generated by engine(s) operating under full thrust conditions.

(a) Prior to shipment to the launch site, each liquid propulsive flight *stage or *module shall be subjected to a full duration captive firing to verify flight readiness of the individual *stage or *module (see Table No. 3).

*For Definition, See Appendix A

(b) Upon receipt at a captive test firing facility, a *stage or *module to be tested shall undergo an inspection to determine configuration adequacy and if any damage has incurred during transportation from the manufacturing facility. The extent of this inspection shall be determined by the *cognizant NASA element but shall, at a minimum, be as rigorous as that to which the item will be subjected upon arrival at the launch site.

(c) Prefiring *checkout procedures and equipment and countdown shall duplicate, as nearly as practicable, those to be utilized during actual launch.

(d) During *acceptance firing test, the *stage or* module flight sequence of events shall be executed, including engine cut-offs and restarts, staging, etc., within the limitations imposed by ground operations and environments of captive firing.

(e) A detailed test procedure shall be generated for each captive firing test. When generated by contractor activities, the test procedure will be prepared for

*For Definition, See Appendix A

and submitted to the *cognizant NASA element for approval.

(f) The *acceptance test firing measuring program shall include all measurements which are to be monitored during actual launch and flight, in addition to measurements necessary to attain the objectives of the *acceptance firing test. Redundant hard-wire measuring systems shall be used to assure test control and data acquisition. Since the vehicle flight measuring system is one of the items being tested, test measurements shall be acquired by facility instrumentation systems rather than the telemetry measuring systems.

(g) At the completion of *acceptance test firing and prior to maintenance, the tested *stage or *module shall be thoroughly checked out for structural, electrical, and functional integrity to assure that no system degradation has resulted from the *acceptance test firing.

(h) After the tested *stage or *module is checked out (paragraph III.G.2(h)) and after maintenance, the tested

*For Definition, See Appendix A

*stage or *module shall be subjected to a post-acceptance firing checkout. The post-acceptance firing checkout shall be equivalent to the manufacturing checkout.

(i) The activity performing the post-acceptance firing *checkout shall be responsible for preparing the tested *stage or *module for shipment to the launch site.

c. Acceptance Environmental Tests

Acceptance environmental tests are *acceptance tests on *flight hardware performed under environmental rigors other than ambient for the prime purpose of verifying the quality of the *flight hardware.

Requirements: To be supplied.

H. Pre-mating Checkout (Individual *Checkout of *Stages and *Modules at the Launch Site

Pre-mating checkout consists of those tests and inspections performed in accordance with approved procedures which are conducted on each flight *stage and *module upon arrival at the launch site and prior to assembly of the complete space vehicle. It will include:

1. A complete inspection to assure that the *stage or *module was manufactured in accordance with approved design and that no deterioration has occurred as a result of storage, packing, handling,

*For Definition, See Appendix A

and transportation from the static firing site.

2. A complete functional test to assure that all operating systems and *components respond or perform in accordance with approved specifications.

3. A complete functional and physical check of all flight and ground system interfaces to assure that correct mating will occur when the *stage or *module is assembled into a complete space vehicle on the launch pad.

   Pre-mating *checkouts shall be performed in accordance with Table No. 3.

Detailed Requirements: To be supplied.

I. Prelaunch *Checkout (assembled *space vehicle)

Definition and Requirements: To be supplied.

J. Test Specification Requirements

To be supplied.

K. Test Procedure Requirements

To be supplied.

*For Definition, See Appendix A

III. GROUND TEST REQUIREMENTS (Continued)

L. Certification of Flight Worthiness of Hardware

To be supplied.

M. Maintenance and *Spare Requirements in Support of Ground Testing

To be supplied.

N. Contractual Requirements

To be supplied.

O. Facility Requirements

To be supplied.

*For Definition, See Appendix A

TABLE NO. 1

*HARDWARE CRITICALITY CATEGORIES FOR USE IN SELECTION OF GROUND TEST TYPES AT VARIOUS LEVELS OF ASSEMBLY

*Hardware Criticality Category No.	
1.	Hardware, *failures of which would result in actual loss (crew exposure beyond emergency limits) of astronauts.
2.	Crew safety hardware,* failure of which would result in actual loss of astronauts (crew exposure beyond emergency limits) by preventing emergency action in the event of *failure of primary *system.
3.	Hardware, *failure of which would result in actual abort of *mission without undue hazard to astronaut.
4.	Hardware, *failure of which would result in 10% or greater probability of loss of *mission without undue hazard to astronauts.
5.	Hardware, *failure of which would result in less than 10% probability of loss of *mission without undue hazard to astronauts.

*For Definition,
See Appendix A

TABLE NO. 2

MINIMUM GROUND TEST REQUIREMENTS FOR*FLIGHT TYPE HARDWARE
(Identical to Flight Hardware in Design and Fabrication)

*Level of Assembly	Test Type	Tests Must be Completed Prior to	*Simulated Environment (% of Flt) [1]Level	[1]Time	Functional Cycles	For Test Requirements See Paragraph
1. *Piece parts, *components and materials	a. *Qual.	Desired: On all parts and components prior to initiation of manufacturing*checkout of first flight*stage or*module.	110 - 125%	125 - 250%	200 - 500%	III.D
		Mandatory: On items falling in hardware categories 1 through 4 prior to initiation of manufacturing*checkout of first flight*stage or*module.	110 - 125%	125 - 250%	200 - 500%	
	b. * Rel.	Mandatory: On all items in categories 1 and 2 prior to initiation of manufacturing *checkout of first manned flight stage or module.	To be determined by Centers in accordance with Test Policy.			III.E
2. *Assemblies	a. *Qual.	Mandatory: On all*assemblies (all hardware categories) prior to initiation of manufacturing*checkout of first flight* stage or* module.	110 - 125%	125 - 250%	200 - 500%	III.D

*For Definition,
See Appendix A

[1]NOTE: Where hardware is subjected to environmental stresses before flight, such as*acceptance test firing(s) and acceptance environmental tests, environmental levels and test time must be expanded to assure that these stresses are accounted for.

TABLE NO. 2 (Continued)

Level of Assembly	Test Type	Tests Must be Completed Prior to	*Simulated Environment % of Flt) [1]Level	[1]Time	Functional Cycles	For Test Requirements See Paragraph
	b. *Rel.	Mandatory: On all *assemblies in categories 1 and 2 prior to initiation of manufacturing *checkout of first manned flight *stage or *module.	To be determined by Centers in accordance with Test Policy.			III.E
3. *Stages and *Modules & IU (including *subsystems)	a. *Qual.	(1) Mandatory: Limited qualification on all stages prior to initiation of manufacturing *checkout of first flight *stage.	(1) *Stages: Ambient except for hot firings.			III.D
		(2) Mandatory: Qualification on all modules prior to initiation of manufacturing checkout of first flight *modules.	(2) *Modules: To be determined by Centers in accordance with Test Policy (where feasible the following shall be adhered to):			
			110 - 125%	125 - 250%	200 - 500%	
4. *Space Vehicle	a. *Dynamic *(Design Development and *Qualification)	Mandatory: Prior to first flight of each major configuration (where significant change of dynamic characteristics occur)	To be determined by the Centers in accordance with Test Policy.			III.F.1

*For Definition
See Appendix A

[1]NOTE: Where hardware is subjected to environmental stresses before flight, such as *acceptance test firing(s) and acceptance environmental tests, environmental levels and test time must be expanded to assure that these stresses are accounted for.

TABLE NO. 2 (Continued)

Level of Assembly	Test Type	Tests Must be Completed Prior to	*Simulated Environment (% of Flt) [1]Level	[1]Time	Functional Cycles	For Test Requirements See Paragraph
	b. Compatibility *(Design Development & *Qualification)	Mandatory: Prior to initiation of* checkout of first flight *stage or* module for each major flight configuration (where significant change in vehicle systems physical or functional characteristics.)	Ambient			III.F.2

[1]NOTE: Where hardware is subjected to environmental stresses before flight, such as* acceptance test firing(s) and acceptance environmental tests, environmental levels and test time must be expanded to assure that these stresses are accounted for.

*For Definition, See Appendix A

TABLE NO. 3

MINIMUM GROUND TEST REQUIREMENTS FOR FLIGHT HARDWARE

Level of Assembly	Test Type	Tests Must be Completed Prior to	*Simulated Environmental Levels	For Test Requirements See Paragraph
1. *Assemblies & Lower	*Receiving	Mandatory: For all functional items prior to incorporation into next level of assembly.	Ambient	III.G.2.b(1)
2. Electrical, Electronic, Electro-mechanical, & Mechanical (Operating) *Piece Parts & *Components	*Screening	a. Desired: For all prior to incorporation into next higher assembly. b. Mandatory: For all in Categories 1, 2, and 3 for manned*flight hardware.	To be determined by Centers in accordance with Test Policy.	III.G.2.a
3. All	* In Process	Mandatory: Prior to next assembly where such*assembly would reduce the capability of a complete functional test of the specific unit.	Ambient	III.G.2.b(2)
4. Electrical, Electronic, Electro-mechanical, & Mechanical*Assemblies	Acceptance Environmental	To be supplied.	To be determined by Centers in accordance with Test Policy.	III.G.2.c
5.*Modules	Acceptance Environmental	To be considered.	To be determined by Centers in accordance with Test Policy.	III.G.2.c

*For Definition, See Appendix A

TABLE NO. 3 (Continued)

Level of Assembly	Test Type	Tests Must be Completed Prior to	*Simulated Environmental Levels	For Test Requirements See Paragrap
6. *Stages IU & *Modules	Manufacturing *Checkout	Mandatory: For all prior to shipment from manufacturer's plant.	Ambient	III.G.2.b(3)
7. * Stages & *Modules	Acceptance Test Firing	Mandatory: For all prior to shipment to the launch site.	Ambient plus that induced by firing.	III.G.2.b(4)
8. *Stages IU &*Modules	*Pre-mating *Checkout	Mandatory: For all prior to moving to vertical assembly bay.	Ambient	III.H
9. *Space Vehicle	Pre-launch *Checkout	Mandatory: For all prior to initiation of countdown.	Ambient	III.I

*For Definition, See Appendix A

IV. FLIGHT TEST REQUIREMENTS

A. General Requirements

Flight tests shall be performed to accomplish the following:

Evaluation of hardware characteristics and operational procedures which cannot be adequately evaluated by ground tests.

Acquisition of flight data and for correlation with ground tests.

*Flight qualification of *launch vehicle prior to manned flights.

*Flight qualification of all *spacecraft *subsystems affecting crew safety or *mission success prior to manned flights.

*Flight qualification of *space vehicle *system (both *space vehicle and *ground support system) insofar as practicable prior to manned flights.

*Flight qualification of *spacecraft with man in the loop.

Crew Training.

1. Unmanned Flight Tests

Unmanned flight tests are conducted for:

a. Flight evaluation of hardware.

b. *Flight qualification of hardware prior to manning.

*For Definition,
See Appendix A

c. Evaluation and *qualification of associated* ground support systems.

*Flight evaluation tests are conducted to:

(1) Evaluate those parameters which could not be simulated on the ground.

(2) Evaluate the validity of *ground qualification tests.

*Flight qualification tests are defined as demonstration of operational suitability of *flight hardware (*component, *assembly, *subsystem, *stage or *module, *launch vehicle, *spacecraft and *space vehicle), techniques, and procedures under the actual conditions which such hardware will encounter in fulfillment of *mission.

It is recognized that judgment must be exercised and that *flight qualification conditions might not be precisely identical to actual *mission conditions. For example, as a prerequisite for first lunar attempt, hardware might be qualified for an extended stay in earth orbit in lieu of all other phases of lunar mission beyond earth orbit.

Evaluation and *flight qualification tests may be combined as appropriate.

As a minimum, all hardware essential to safe return of astronauts shall be flight qualified prior to manned flight.

Unmanned flight tests shall be performed in accordance with paragraphs IV.C.1, 2, 4, and 6 below.

*For Definition, See Appendix A

2. Manned Flight Tests

Manned flight tests are conducted for:

a. Evaluation of man-machine relationship

b. *Qualification of man-machine relationship prior to first lunar landing attempt.

Manned flight tests shall be performed in accordance with paragraphs IV.C.3, 5, and 7 below.

B. Requirements in Support of Flight Tests

1. Prerequisite to Flight Tests

*Qualification and certification requirements stipulated in paragraph III. D. and paragraph III .L. shall be fulfilled as a prerequisite to flight tests.

2. Prohibition of Flight Use of Ground Test Hardware

Hardware that has been subjected to ground testing for development, *qualification, or *reliability shall not be incorporated into flight vehicles.

3. Control of Operating Times of Critical *Components and *Assemblies in *Flight Hardware

The maximum allowable operating times of all critical *components and *assemblies shall be established. Records shall be kept on the cumulative actual operating time on each of the corresponding

*For Definition, See Appendix A

items. In each case when the accumulated operating time plus the anticipated time during follow-on *checkout and flight exceeds the maximum allowable operating time, replacement must be made. With some items, such as valves and relays, the basis of use should be number of operations rather than time.

4. *Test Networks

Test networks shall be designed to permit installation and removal from flight hardware with minimum effects on operational networks.

5. Launch Operations Plan

A launch operations plan shall be developed by the Launch Operations Center (LOC) with assistance of other Centers.

This plan shall incorporate:

a. The Flight Test Directive (see paragraph VB6).

b. Launch area safety.

c. Atlantic Missile Range (AMR) range safety criteria as applicable.

6. Flight Operations

Flight operations plans, including flight safety plans, shall be developed for:

*For Definition, See Appendix A

a. Unmanned Saturn flights by Marshall Space Flight Center (MSFC) with assistance from MSC.

b. Manned Saturn flights and unmanned pad abort and Little Joe II flights by Manned Spacecraft Center (MSC) with assistance from MSFC.

The responsibilities of Integrated Mission Control Center (IMCC), LOC, AMR, MSFC and others to be clearly delineated.

7. Maintenance in Launch Area

A plan for maintaining the space vehicle and ground support system in th launch area shall be developed by:

To be determined.

8. Maintenance During Flight

A plan for*checkout, trouble shooting, repair, substitution or replacement of hardware during flight shall be developed by MSC with assistance by other Centers as required.

9. Spares

The respective Centers shall take necessary measures to insure:

a. That adequate selective*spares (*assemblies,*components, and parts) are available to support the*flight hardware from its manufacture through the actual launch of the hardware.

b. That adequate*spare*stages and*modules are available to support the*stage and*module flight test program.

To be augmented.

*For Definition, See Appendix A

10. Flight Data Evaluation and Correction of Critical Deficiencies:

The Centers shall provide the necessary personnel and facilities to allow adequate reduction, analysis and evaluation of data and correction of critical deficiencies between flights within the approved flight schedules.

11. *Failure Correction

In the event of a critical (*hardware criticality categories 1, 2, and 3) flight*failure, the following actions shall be taken:

a. The deficiency corrected prior to follow-on flight(s), or

b. A*waiver obtained from Director, OMSF.

12. Flight Test Reports

The following post-firing reports shall be supplied to the Director, OMSF, for each flight.

a. LOC shall supply a "quick look" report by teletype within 24 hours after flight.

b. The Center responsible for the flight (see Flight Mission Assignments Summary) shall supply a TWX report within two days and a letter report within 10 days after flight. Other Centers will support the Center responsible for preparation of the report.

c. The Center responsible for flight shall provide a final evaluation report within 60 days after flight. Other Centers will support the Center responsible for preparation of report.

*For Definition, See Appendix A

Further definition of content and distribution to be provided by OMSF.

13. Orbital Refuse

MSC and MSFC shall provide for the prevention of excessive accumulation of their respective hardware in earth and lunar orbit. The following shall be considered in test planning in order to prevent excessive accumulation in earth and lunar orbit and inadvertent earth reentry:

a. Orbital life of specific hardware.

b. Emission of electromagnetic radiation after equipment has fulfilled its use.

c. Hardware disintegrating while in orbit.

d. Tracking of material and recording location and trajectory.

14. Satellite for Checkout of Communications and Tracking Systems Immediately Preceding Manned Flights

To be supplied.

IV. FLIGHT TEST REQUIREMENTS (Continued)

C. Specific Flight Test Requirements

1. Minimum Pad abort and Little Joe II Flight Test Requirements (Prerequisite to manned flight)

a. The *qualification of the production Launch Escape System (LES and CM) under the following conditions:

(1) Pad abort

(2) Simulated Saturn abort at:

(a) High dynamic pressure (such that Escape Configuration is subjected to most adverse conditions)

(b) High altitude prior to jettison of LES.

b. In-flight Evaluation of LEM Propulsion System

2. Minimum Apollo/Saturn I Unmanned Flight Test Requirements (Prerequisite to Apollo/Saturn I Manned Flight)

a. *Qualification of the Launch Vehicle (LV) including:

(1) Structure

(2) Propulsion systems (including capability to insert specified payload into earth orbit)

(3) Stage separation

(4) Guidance and control (including capability to insert payload into specified earth orbit).

(5) *Emergency Detection System (EDS)

(6) Electrical Networks and Power Supplies

*For Definition, See Appendix A

(7) RF and Instrumentation Systems

(8) Environmental Control of Instrument Unit (IU)

b. *Qualification of the Command*Module - Service*Module (CSM) to at least the conditions under which Apollo/Saturn I manned flights will be made including:

(1) Minimum orbital staytime of three orbits

(2) LES jettison

(3) Structures, including Command/Service*Module (CSM)

(4) Command*Module (CM) Heat Shield (for orbital reentry)

(5) Service*Module (SM) Reaction Control System (RCS) to the extent feasible without man in loop)

(6) Command*Module - Service*Module Separation Systems

(7) Command*Module (CM) Reaction Control System (RCS)

(8) Crew Safety System (to the extent feasible without man in loop)

(9) SM Propulsion System, including restart

(10) Stabilization and Control System

(11) Electrical Power Systems

(12) Communications and Instrumentation System (to the extent feasible without man in loop)

*For Definition, See Appendix A

(13) Guidance and Navigation System (to the extent feasible without man in loop)

(14) Earth Landing System for water landing

(15) Environmental Control Systems (to the extent feasible without man in loop)

(16) Crew Systems (to the degree feasible without man in loop)

c. *Qualification of the *Space Vehicle

(1) Compatibility of the *launch vehicle and the Command/ Service *Module (CSM)

(2) Separation of the *launch vehicle and the Command Service *Module (CSM)

d. *Qualification of the *Ground Support Systems

e. *Qualification of flight operations and ground operations (including recovery)

3. Minimum Apollo/Saturn I Manned Flight Test Requirements

a. Continue *flight qualification tests of *subsystems which were qualified per paragraph c.(2) above in order to increase the engineering confidence level.

*For Definition, See Appendix A

IV. FLIGHT TEST REQUIREMENTS (Continued)

b. Complete* qualification of Command/Service* Module (CSM) *subsystems which could not be fully qualified without man in the loop, including:

(1) *Qualification of Service* Module Reaction Control System for changing and maintaining attitude of CSM with manned control.

(2) *Qualification of CM RCS including capability of providing adequate manueverability during reentry with manual control.

(3) Crew Safety System

(4) *Qualification of the Guidance and Navigation System

(5) *Qualification of voice communications

(6) Environmental Control Systems

(7) Crew Systems

c. * Qualification of operational characteristics of the crew-equipment (including compatibility of the two) under an extended orbital stay of at least _____.

d. Provide ground and flight crew training.

4. <u>Minimum Apollo/Saturn IB Unmanned Flight Test Requirements (Prerequisites of Apollo/Saturn IB Manned Flight)</u>

a. *Qualification of the* launch vehicle, including:

*For Definition, See Appendix A

IV. FLIGHT TEST REQUIREMENTS (Continued)

(1) Modifications of S-I to S-IB configuration

(2) S-IVB, including:

(a) Structure

(b) Propulsion System

(c) Roll control during propulsion phase

(d) Attitude control during non-propulsion phase

(e)* Emergency Detection System (EDS)

(f) Electrical Networks and Power Supplies

(g) Instrumentation

(3) Instrument Unit (IU), including:

(a) RF and Instrumentation Systems

(b) Guidance and Control (including insertion of payload into specified earth orbit)

(c) Environmental Control of IU

(d) Orbital* Checkout of equipment

(e) Structure

(f) Electrical Networks and Power Supplies

(4) S-IB/S-IVB Separation

*For Definition,
See Appendix A

(5) Insertion of Specified Payload into Earth Orbit

b. *Qualification of the* Spacecraft (less LEM lunar descent stage) to at least the conditions under which Apollo/Saturn IB manned flights will be made, including:

(1) Critical modifications to hardware utilized on Apollo/Saturn I which have not been flight qualified.

(2) Continue* flight qualification tests of* subsystems which were qualified on Saturn I flights in order to increase the engineering confidence level.

(3) Production S/C adapter (structure and expulsion from LEM)

(4) CSM/LEM Adapter separation

(5) LEM/Adapter/IU separation

(6) * Spacecraft orbital * checkout

(7) Production LEM during free flight, to include:

(a) Lunar ascent stage propulsion, including restart

(b) Structure

(c) Guidance and Navigation System (to the extent feasible without man in loop)

*For Definition,
See Appendix A

(d) Environmental Control System (to the extent feasible without man in loop)

(e) Electrical Networks and Power Supplies (to the extent feasible without man in loop)

(f) Communications and Instrumentation System (to the extent feasible without man in loop)

(g) Reaction Control System (to the extent feasible without man in loop)

(h) Stabilization and Control System (to the extent feasible without man in loop)

(i) Crew Systems (to the extent feasible without man in in loop)

c. *Qualification of the Apollo/Saturn IB* space vehicle including:

Compatibility of LV and SC

d. Continue qualification of ground and flight operations.

e. *Qualification of* ground support systems.

*For Definition,
See Appendix A

f. Insofar as feasible (within Saturn IB payload and operational capabilities), qualify all* spacecraft* subsystems of the configuration to be utilized for the first lunar attempt.

5. Minimum Apollo/Saturn IB Manned Flight Test Requirements (Prerequisites to First Manned Lunar Landing Attempt)

a. Continue flight* qualification tests of* subsystems of* spacecraft which have been previously qualified in order to increase the engineering confidence level.

b. Complete* qualification of LEM* subsystems which could not be fully qualified without man in loop (see paragraph 4.b(7)).

c. * Qualification of operational characteristics of the crew-equipment (including compatibility of two) under an extended orbital stay of at least 14 days.

d. * Qualification of LEM excursion, rendezvous, and docking with CSM.

e. Verification of operational procedures and techniques.

f. Provide ground and flight crew training.

g. Continue* qualification of *ground support systems.

6. Minimum Apollo/Saturn V Unmanned Flight Test Requirements (Prerequisites to Manned Apollo/Saturn V Manned Flight)

*For Definition, See Appendix A.

IV. FLIGHT TEST REQUIREMENTS (Continued)

a. *Qualification of LV, including:

(1) S-IVB *stage characteristics which could not be qualified within Saturn IB payload and operational capabilities, such as S-IVB engine restart.

(2) Structures

(3) Propulsion Systems

(4) *Stage Separations

(5) Guidance and Control (including capability to insert payload into specified orbit and injection into translunar trajectory.

(6) *Emergency Detection System

(7) Electrical Networks and Power Supplies

(8) RF and Instrumentation Systems

(9) Environmental Control of Instrument Unit

b. Final *qualification under Saturn V environment of all *spacecraft *subsystems of the configuration to be utilized for the first manned lunar attempt including but not limited to the following:

*For Definition,
See Appendix A

(1) *Qualification of Command *Module including heat shield at minimum reentry velocity of 36,000 feet per second

(2) Minimum orbital staytime of 14 days.

(3) *Qualification of fully fueled SM and LEM propulsion system including multiple restarts.

(4) *Qualification of LEM descent stage propulsion system.

c. Completion of *qualification of all *ground support systems required to support first manned lunar landing attempt from prelaunch through recovery.

d. Completion of *qualification of ground and flight operations required to support first manned lunar landing attempt from prelaunch through recovery.

7. Minimum Apollo/Saturn V Manned Flight Test Requirements (Prerequisites to first lunar landing attempt):

*Qualification in earth oribt of a fully operational system.

To be augmented.

*For Definition, See Appendix A

V. TEST PLAN REQUIREMENTS

A. General

This section sets forth the requirements for Apollo System Test Plan to provide:

1. Plans for implementation of those minimum test requirements specified in sections III and IV.
2. Consolidated and integrated Apollo System Test Plan essential for effective systems management.

Apollo System Test Plans encompass the ground test plans and flight test plans for the Apollo programs, and will contain as a minimum the following:

1. Apollo System Test Plan Summary
2. Apollo Flight Mission Assignments Summary
3. Ground Test Plans for Stages and Modules
4. Apollo Space Vehicle Qualification Test Matrix
5. Flight Test Plans for Individual Flights
6. Flight Test Directives for Individual Flights
7. Center Test Plans

B. Preparation of Test Plans

The Centers shall prepare the individual documents listed above, except for the Apollo System Test Plan Summary, the Apollo Flight Mission Assignments Summary, and the Flight Test Plans for Individual Flights which will be prepared by OMSF with inputs from the Centers.

V. TEST PLAN REQUIREMENTS (Continued)

The following guidelines govern the preparation of the Apollo System Test Plans:

1. Apollo System Test Plan Summary (See Chart 1).

An Apollo System Test Plan Summary will be prepared to depict the integration of the major ground test and flight test programs.

The intent of this is to depict on a single plan an integrated and consolidated top level summary of various test planning data included in the Apollo System Test Plans.

This summary will depict:

a. The major activities of the ground test program down to and including the* stage and* module level.

b. Significant milestones within each of the major activities.

c. The flight program showing flight schedules and major flight* missions on individual flights.

The time phasing of data presented on the summary will be based on Center inputs submitted in accordance with:

OMSF Instruction M-IM 9330.002, dated December 5, 1963

OMSF Instruction M-IM 9330.003, dated January 2, 1963.

This summary will be prepared and issued by OMSF based on Center inputs.

*For Definition, See Appendix A

V. TEST PLAN REQUIREMENTS (Continued)

2. Apollo Flight* Mission Assignments Summary (See Page xiii, OMSF Reference Document No. 2)

This document contains Flight Mission Assignment Summary and Configuration and Flight Data Summary Charts for Apollo/Saturn and Apollo/Little Joe II.

The Apollo Flight Mission Assignments Summary was issued as an OMSF requirements document for use by the Centers and OMSF Directorates for planning and implementing the flight test programs and other related activities.

Periodic revisions will be made as flight* missions are better defined and changes are approved.

3. Ground Test Plans for* Stage and* Modules (See Chart 2).

A summary Ground Test Program Network (PERT type) shall be prepared for each launch vehicle stage and spacecraft module by the respective Centers.

The network will include as a minimum, plans for each ground test* stage and* module (i.e., battleship, all system, dynamic, water recovery, impact tests, etc.).

Test activities and events selected for inclusion in these charts will be to the level required to depict significant* ground test qualification and constraints leading up to the first flight of the stage or module. If one test or phase of testing must be completed prior to the beginning of another test, this shall be depicted (e.g. facilities* checkout prior to flight* stage* checkout, battleship tests prior to all-systems tests, etc.).

*For Definition, See Appendix A

Supporting information for each major test of a *stage or *module shall be supplied with each PERT type chart to include as a minimum the following:

a. Objectives of Test

b. Hardware Configuration

c. Sequence of Events or Operations

d. Testing environments

e. Duration of Tests

4. Apollo Space Vehicle Qualification Test Matrix (See Chart 3)

Chart 3 will depict in matrix form the *qualification plan for each item of hardware from beginning of *ground qualification tests through *flight qualification tests.

Entries on Chart 3 shall be made down to *assembly level; however, items in *hardware criticality categories 1 and 2 (see Table No. 1, page 27) will be included regardless of hardware level.

*Ground qualification and *reliability test plans for the listed items shall be referenced in the matrix.

*Hardware criticality categories will be assigned to each item based on the failure effects analysis (Reference paragraph III.B.2.d).

These documents will be prepared by the Centers and issued as a part of the Apollo System Test Plans.

*For Definition, See Appendix A

V. TEST PLAN REQUIREMENTS (Continued)

5. Flight Test Plans for Individual Flights (See Sample 1)

MSC and MSFC shall prepare flight test plans for each individual flight in accordance with Sample No. 1.

For unmanned Saturn flights, MSC shall submit the *spacecraft portion of the flight test plan to MSFC for combination with the *launch vehicle portion and for transmittal to OMSF and all Centers. For manned Saturn flights, MSFC shall submit the *launch vehicle portion to MSC for combination with the *spacecraft portion and for transmittal to OMSF and all Centers. Each individual flight plan transmitted shall bear the signatures of the person within each Center responsible for the particular flight.

For Pad Aborts and Little Joe II flights, MSC shall prepare and issue the individual flight test plans.

6. Flight Test Directives for Individual Flights

To be supplied.

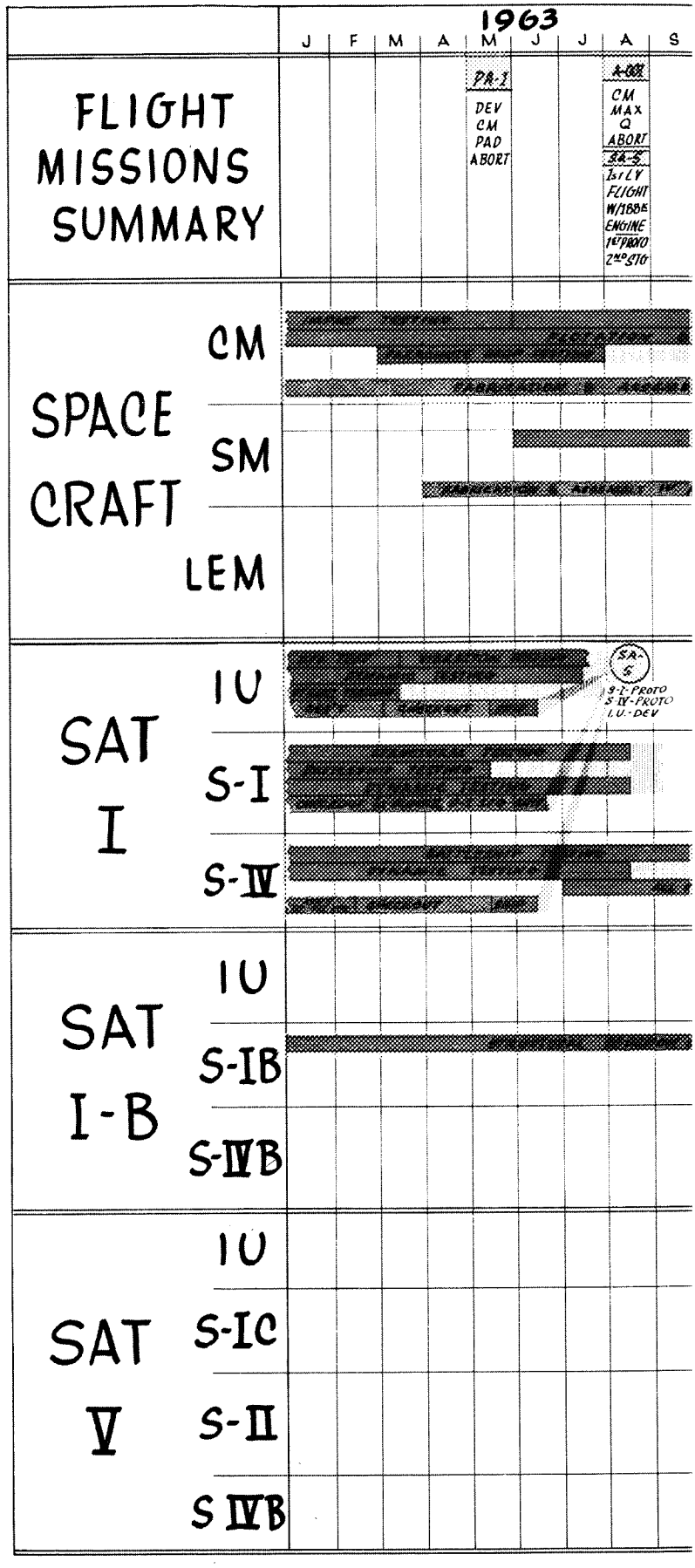
7. Center Test Plans

A complete bibliography of Center test plans shall be prepared by the Centers for inclusion in the Apollo System Test Plan Document.

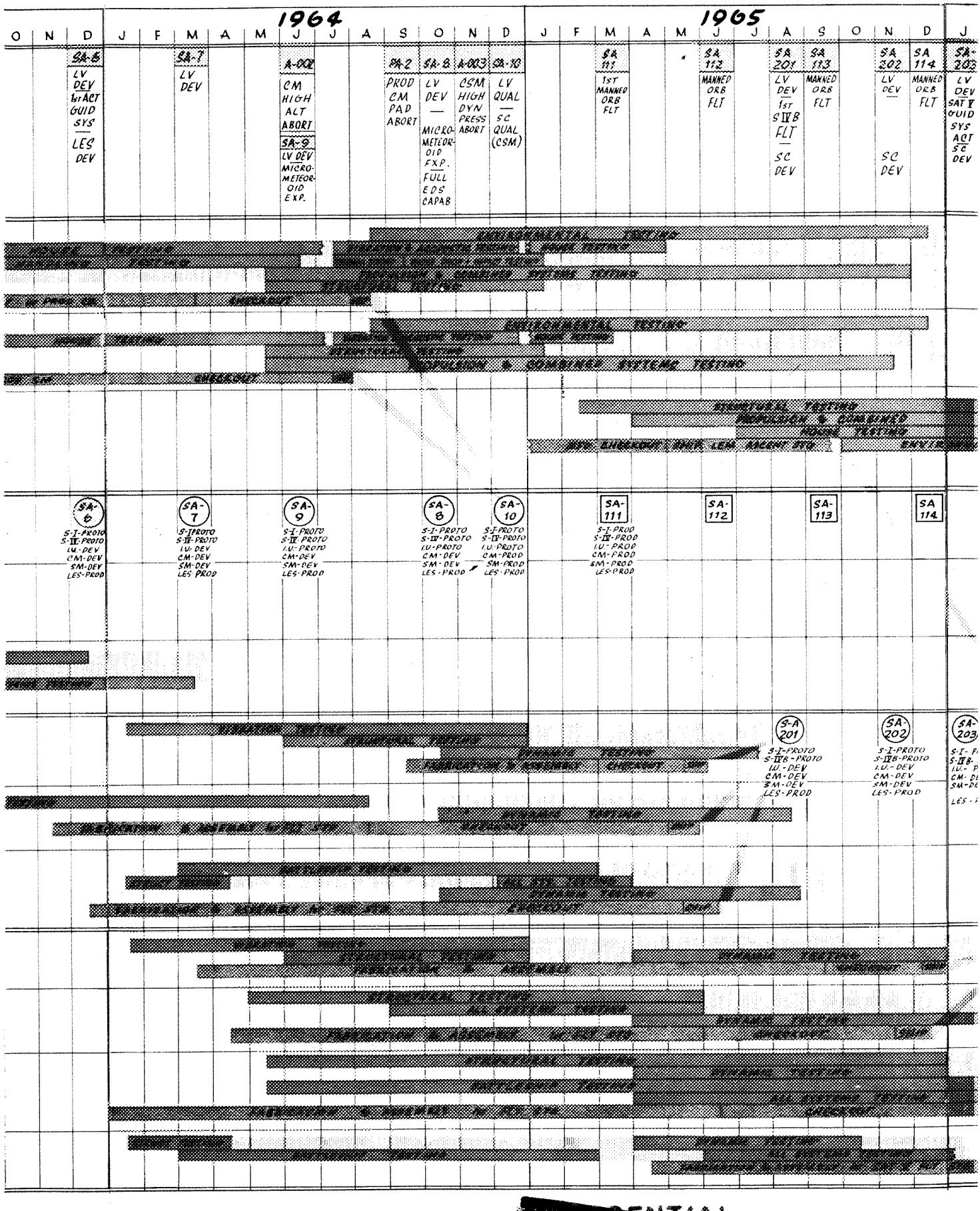
*For Definition, See Appendix A

[redacted]

(SAMPLE) APO



LLO SYSTEM TEST PLAN



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SUMMARY (SAMPLE)

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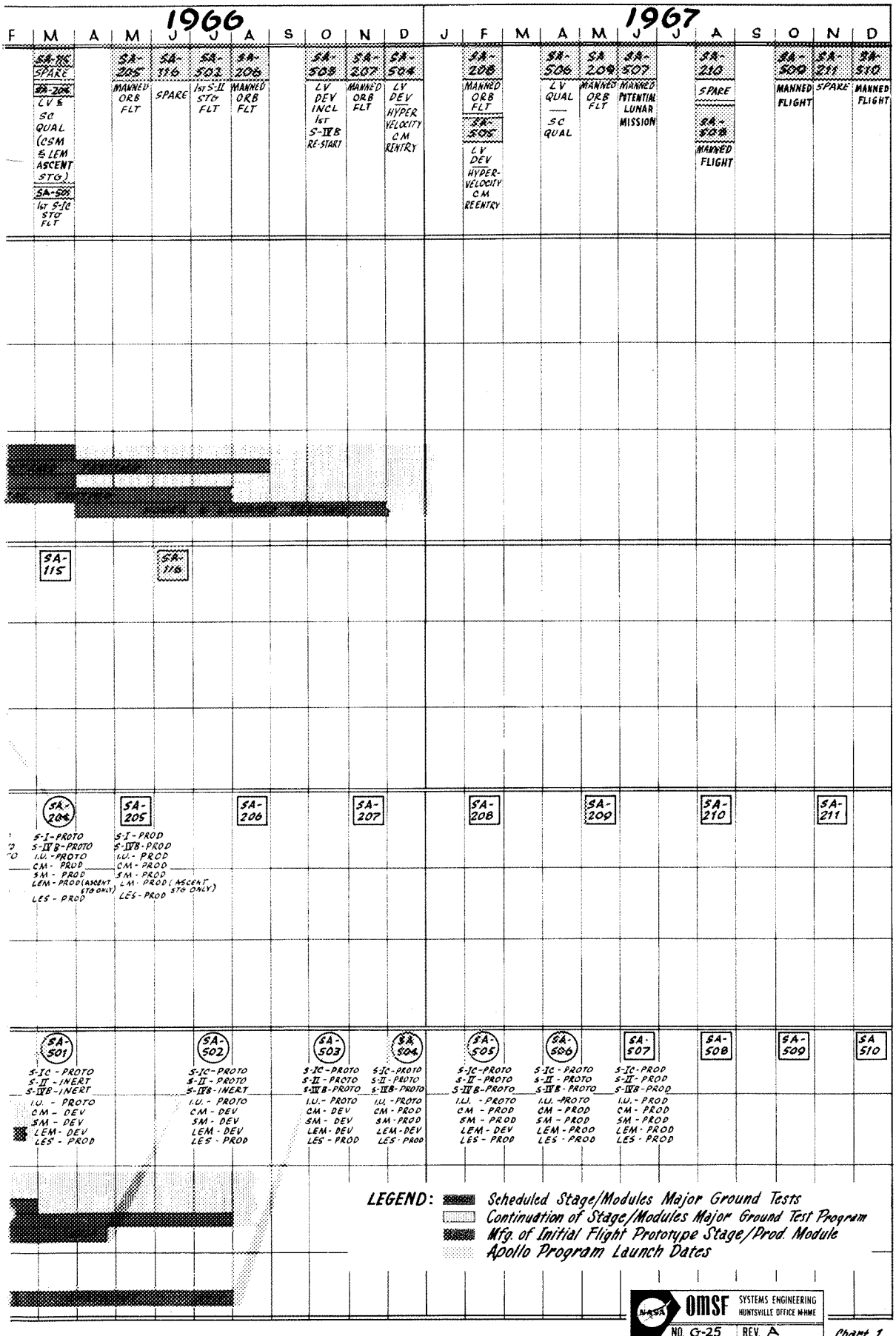

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NO. G-25 REV. A

DATE APR 15'63 REF.

SAMPLE

APOLI

HARDWARE IDENTIFICATION			GROUN
LEVEL	GENERATION BREAKDOWN	HARDWARE CRITICALITY CATEGORY	QUALIFICA
SPACE VEHICLE	APOLLO SPACE VEHICLE		
LV OR SC	LAUNCH VEHICE		
STAGE OR MODULE	INST. UNIT		
SUBSYSTEM	GUID. & CONTROL		
ASSEMBLY	STAB. PLATFORM	2	MSFC-5
	MOD I		
	MOD II		

HARDWARE GENERATION BREAK DOWN TO ASSEMBLY LEVEL, HOWEVER, HARDWARE IN CRITICALITY CATEGORIES 1 & 2 (SEE TABLE 1, Pg. 27) WILL BE INCLUDED REGARDLESS OF HARDWARE LEVEL. MODEL CHANGES OF ITEMS SHALL BE SHOWN

HARDWARE CRITICALITY CATEGORY NUMBER AS DEFINED IN TABLE NO. 1 PAGE 27

LO SPACE VEHICLE QUALIFICATION MATR
HARDWARE IDENTIFICATION

ID TESTS		FLIG																
		LITTLE JOE II								SATURN I								
TION	RELIABILITY	PA 1	PA 2	LJ II-1	LJ II-2	LJ II-3	LJ II-4	LJ II-5	LJ II-6	SA 1	SA 2	SA 3	SA 4	SA 5	SA 6	SA 7	SA 9	SA 8	SA 10
		◄----UNMANNED------►								◄----- UNMANNED -------►								
	MSFC-3											E	E	E	E	E	E	E	Q

THIS ENTRY INDICATES ITEM IS RELIABILITY TESTED. THE CENTER PLAN(S) WHICH DETAIL THE RELIABILITY TESTS CONDUCTED WILL IDENTIFIED BY A NUMBER ENTRY WHICH CORRESPONDS WITH NUMBER AS LISTED IN THE BIBLIOGRAPHY OF CENTER TEST PL (SEE PAR 7, Pg. 54)

THIS ENTRY INDICATES ITEM IS GROUND QUALIFIED PRIOR TO 1st FLIGHT. THE CEN TEST PLAN(S) WHICH DETAIL THE QUALIFICATION TEST CONDUCTED WILL BE IDENTIFI A NUMBER ENTRY WHICH CORRESPONDS WITH THE PLAN NUMBER AS LISTED IN THE BIBLIOGRAPHY OF CENTER TEST PLANS. (SEE PAR 7, Pg. 54)

IX

SAMPLE

HT TESTS

	SATURN 1-B										SATURN V								
SA 111	SA 112	SA 113	SA 114	SA 201	SA 202	SA 203	SA 204	SA 205	SA 206	SA 207	SA 208	SA 209	SA 210	SA 501	SA 502	SA 503	SA 504	SA 505	SA 506	SA 507	SA 508	SA 509
◄-MANNED- ►				◄UNMANNED►				◄ - -MANNED- - - ►						◄ - -UNMANNED- - ►						◄ -MAN- ►		
O	O	O	O	E	E																	
						E	Q	O	O	O	O	O	O	E	E	E	E	E	Q	O	O	O

TEST
BE
THE PLAN
ANS.

TER
D BY

"E" INDICATES * FLIGHT EVALUATION TEST OF ITEM

"Q" INDICATES * FLIGHT QUALIFICATION TEST OF ITEM

"O" INDICATES * OPERATIONAL STATUS

* FOR DEFINITIONS SEE APPENDIX "A"

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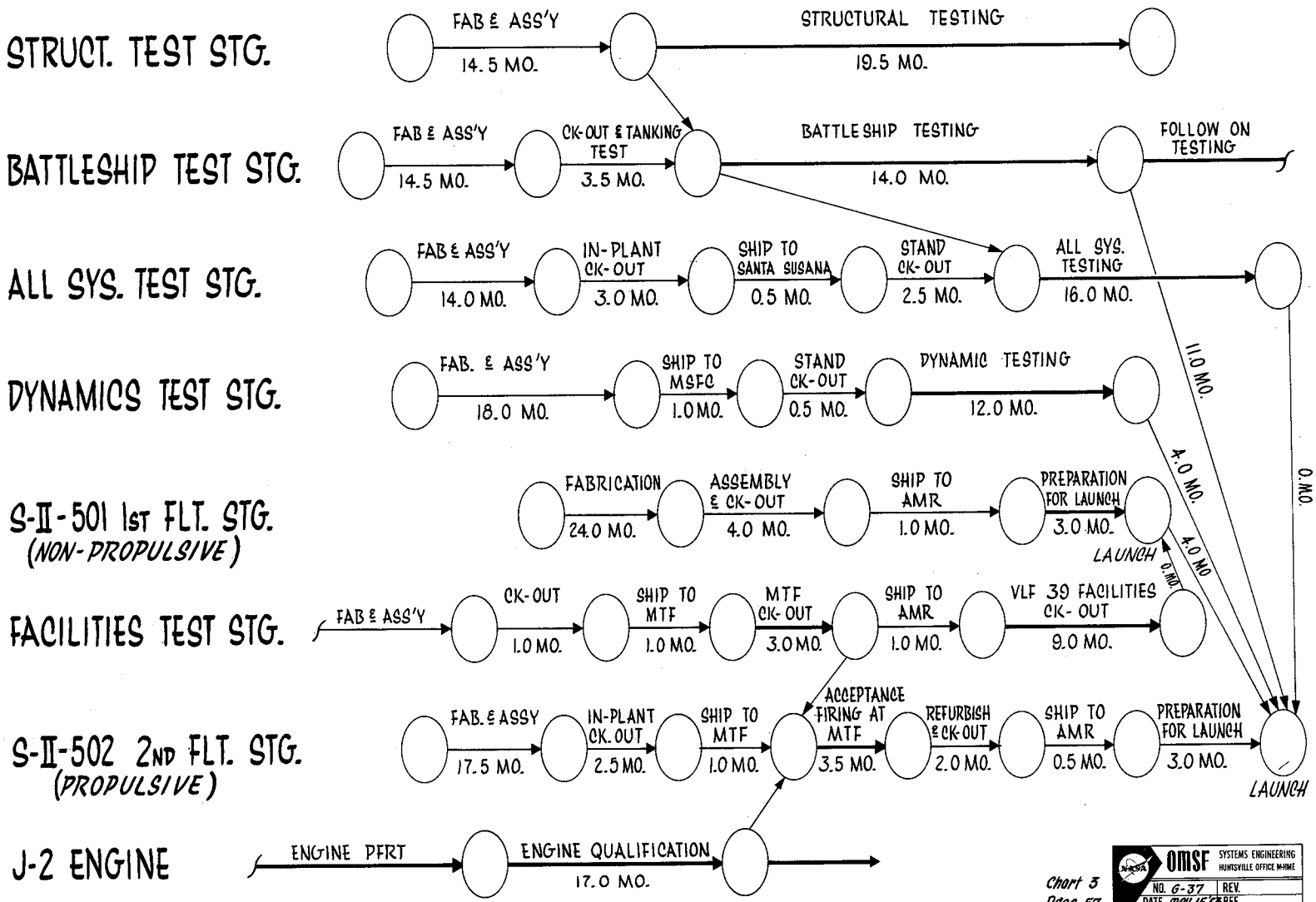
NO.	REV.
DATE	REF.

S-II STAGE - GROUND TEST PROGRAM NETWORK (SAMPLE)



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DATE MAY 1963 REF.

VI. DOCUMENTATION

To be supplied.

A P P E N D I X "A"

Summary of Definitions

(Incomplete)

The purpose of this summary is to define the terms utilized in this document as they specifically apply to the Apollo Program.

Acceptance Tests

A test performed at any level of assembly (such as component, assembly, sub-system, etc.) for the purpose of demonstrating compliance with procurement specifications and functional, acceptability. This test is normally performed under the surveillance of the customer prior to transfer of ownership.

Acceptance Test Firing

A captive firing of a flight stage or module for the purpose of verifying the performance of all systems under environments generated by engine(s) operating under full thrust conditions. It is one of several acceptance tests performed, normally the last.

All Systems Test

(To be supplied)

Assembly

The smallest physical entity (usually separable by plugs and/or bolts) consisting of piece parts and components, or sub-assemblies thereof which perform a definable function within a sub-system. Examples: Engine, stabilized platform, control computer, and interstage adapter.

Battleship Test

Static test on a propulsion system utilizing a non-flight vehicle to provide performance data on original design and design changes.

Boiler-Plate

A piece of test hardware, generally non-functioning, which structurally simulates weight, center of gravity and aero-dynamic configuration. It may incorporate interim structural shells or dummy structure. Internal systems may be inert or contain selected functional sub-systems for obtaining flight data for development purposes (sometimes referred to as dummy or inert hardware).

Checkout

A functional test for determining the readiness of equipment to perform a required function or operation.

Class of Hardware

All equipment produced to a specific design for a specific application.

Cognizant NASA Element

The organizational unit of NASA which has technical direction or managerial responsibility for specified work.

Component

A combination of parts which cannot be disassembled in the field without invalidating functional integrity. Examples: Valve, relay, actuator, gyro, turbopump, and accelerometer.

Criticality

The numerical weighting applied to hardware based on the relative effects of equipment malfunctions on crew safety or mission success as determined from a detailed failure effects analysis of the space vehicle.

Critical Failure

(To be supplied)

Design Development Tests

Tests conducted to formalize or crystallize hardware design. They may be employed to determine feasibility of approach, usability of standard hardware, or for evaluation of performance of hardware and techniques under simulated environmental conditions.

Design Specification

A document prescribing criteria to be satisfied in designing a particular part, component, assembly, sub-system, or system. Typical criteria include performance requirements under specified environments, interface requirements, size, weight, ruggedness, safety margins, derating factors, and apportioned reliability goal (with definition of failure).

Documentation

Recorded information required for control of design, production, procurement, supply use and maintenance of hardware, e.g. drawings, specifications, handbooks, manuals, etc.

Dynamic Test

Tests designed to determine the flight structural dynamic characteristics (bending modes, structural feedback constants, damping constants, natural reasonances, etc.) under controlled laboratory conditions. These tests are required to assure correctness and adequacy of these same characteristics as determined by mathematical analysis.

Emergency Detection System (EDS)

(To be supplied)

Failure

The event after which a system, sub-system, component, or part is unable to perform its required function within specified tolerances.

Failure Analysis

The study of a specific failure to determine the circumstances which caused the failure, and to arrive at a course of corrective action to prevent recurrence.

Failure Effect Analysis

Study of the potential failures which might occur in any part of a system to determine the probable effect on other parts of the system, crew safety and probable mission success.

Failure Mode

The manner in which a part, component, system or equipment fails. (Example: Shear during acceleration).

Flight Evaluation

Appraisal of in-flight performance.

Flight Environment

The conditions to which items of hardware will be exposed during the flight mission profile. This consists of natural environments and induced environments. Reference Natural Environment and Physical Standard Specification. (M-DE 8000.005A)

Flight Hardware

Hardware assigned for flight (See Flight Mission Assignment Summaries).

Flight Qualification

The successful accomplishment of Flight Qualification Tests.

Flight Qualification Tests

Flight tests conducted to demonstrate operational suitability of flight hardware (component, assembly, sub-system, stage or module, space vehicle), techniques, procedures, etc. under the actual conditions the hardware will encounter in fulfillment of mission.

Flight Type Hardware

Hardware which is identical to flight hardware in design and fabrication and assigned for uses other than flight, e.g. ground test or spare.

Functional Test

A test performed to demonstrate that the operation of the item tested is as specified (required). It may be performed under ambient or simulated environments.

Generation Level

The level of assembly of hardware (part, component, assembly, sub-system, stage or module and space vehicle).

Ground Qualification

(To be supplied)

Ground Qualification Tests

Functional tests performed on flight type hardware at simulated levels of environments equal to or slightly above the predicted or measured flight environment.

Ground Support Systems

All equipment necessary to support the operations of receiving, handling, assembly, test, checkout, launch, flight and recovery of the entire or any part of a Space Vehicle.

Hardware Criticality Categories:

No. 1 - Hardware, failure of which would result in the actual loss (crew exposure beyond emergency limits) of astronaut(s).

No. 2 - Crew Safety Hardware, failure of which would result in actual loss (crew exposure beyond emergency limits) of astronaut(s) by preventing emergency action in the event of failure of the primary system.

No. 3 - Hardware, failure of which would result in actual abort of mission without undue hazard to astronaut(s).

No. 4 - Hardware, failure of which would result in 10% or greater probability of loss of mission capability without undue hazard to astronaut(s).

No. 5 - Hardware, failure of which would result in less than 10% probability of loss of mission capability without undue hazard to astronaut(s).

In-Process Tests

All production line tests performed at intermediate points between receiving tests and start of final manufacturing checkout.

Interface

The physical and functional interaction between two parts, components, sub-systems, systems, or any mode of contact between two or more elements, including the crew, during any operation of a system.

Launch Vehicle (LV)

That hardware designated as the launch vehicle in the Flight Configuration and Flight Data Summaries of the "Apollo Flight Mission Assignments" (M-DE 8000.005A).

Limited Qualification

(To be supplied)

Mission

Reference: Apollo System Specification.

Module

A major sub-division of a spacecraft (e.g. command module, service module, lunar excursion module).

Non-Destructive Tests

Testing of a nature that does not impair the usability of the item or materially affect the life expectancy.

Operational Status

The status of an item of hardware which has completed flight qualification tests and is ready to perform flight missions other than flight testing of the item itself.

Piece Part

An article that is not functionally useful by itself, but is an element of a higher level of assembly. It is of such construction further disassembly is not practical.

Pre-Launch Checkout

(To be supplied)

Preliminary Flight Rating Test (PFRT)

A series of functional tests performed on a rocket engine to demonstrate its readiness for use in unmanned flight testing. The tests are designed to cover all phases of engine operation.

Pre-Mating Checkout

Individual tests of stages and modules to verify that the functional integrity of the stages or modules has not been compromised by transportation, handling, environment, deterioration due to aging, etc., and to make a final determination of compatibility with other stages and modules before assembly into the space vehicle.

Production Hardware

Flight or flight type hardware produced in accordance with a firm design which has been established by design development tests as suitable for flight operations.

Production Tests

Functional and/or environmental tests conducted on all fabricated or procured hardware prior to, during, or at the completion of assembly or manufacture for the purpose of determining whether the performance, tolerances, and quality are within specified limits.

Qualification

A successful completion of qualification tests.

Quality Defect

Nonconformance with drawings and specifications due to workmanship or control procedures.

Receiving Tests

Non-destructive, functional tests performed on parts, components, or assemblies when received at the assembly facility.

Reliability

The probability that an item of hardware will accomplish a specified task under a specified set of conditions within a specified period of time.

Reliability Assessment

An analytical determination of reliability of an item of hardware. Such assessments usually employ mathematical modeling, applicable test results, and engineering judgement.

Reliability Tests

Any test conducted with the prime purpose of assessing reliability.

Safety Factor

The ratio of the load that would cause failure of a member or structure to the load that is imposed upon it in service. It also may be used to represent the ratio of failure to service value of speed, deflection, voltage, temperature, or other stress - producing factor.

Safety Margin

The difference in average strength and average stress for a number of items of hardware of the same class, expressed in standard deviations.

Sample

Number of units of a specific class of hardware selected for the purpose of inspection or test.

Screening Tests

Test employing non-destructive environmental, electrical, and mechanical stresses, separately or in combination, to identify individual component parts exhibiting abnormal or marginal performance characteristics.

Simulated Environment

(To be supplied)

Spacecraft (SC)

That hardware designated as the spacecraft in the Flight Configuration and Flight Data Summaries of the "Apollo Flight Mission Assignments" (M-DE 8000.005A).

Space Vehicle

That hardware designated as the space vehicle in the Flight Configuration and Flight Data Summaries of the "Apollo Flight Mission Assignments" (M-DE 8000.005A).

Spare Parts

Items of hardware available for incorporation into all levels of assembly of space vehicles, and ground support equipment as replacements for defective items.

Stage

The independent propulsive sections of a launch vehicle.

Standard Hardware

Hardware of established design which has encountered extensive use.

Sub-System

A combination of parts, components and assemblies joined together to perform a specific operational function, e.g. Guidance and Control system, Propulsion system, Instrumentation system, Crew Safety system, etc.

Test Network

Networks utilized solely for the purpose of acquiring or transmitting test data as opposed to performance of mission.

Waiver

Release of responsible agency from compliance with requirements.

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OFFICE OF MANNED SPACE FLIGHT

Program Requirement Document

SAMPLE
PRELIMINARY
APOLLO/SATURN I FLIGHT TEST PLAN
FOR
SA-6

Effective Date:

Date: February 15, 1963

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C.

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Table Of Contents

Definitions

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Launch Vehicle NR. SA-6

Spacecraft Nr. BP 13

Mission Nr. A-101

Launch Date: Dec.'63

~~Confidential~~

I. MISSION OBJECTIVES

1. Performance test of a two-stage Saturn I launch vehicle.
2. Demonstrate physical compatibility of Launch Vehicle and Spacecraft (LV/SC) under preflight and flight conditions.
3. Determine launch and exit environmental parameters to verify design criteria.
4. Determine structural characteristics of Launch Escape System (LES).
5. Verify Launch Escape Tower separation characteristics.
6. Demonstrate compatibility of the R&D communications and instrumentation systems between:
   (a) LV & SC
   (b) LV Systems
   (c) Space Vehicle (SV) and Ground
7. Verify operational suitability of AMR ground tracking system.

II. FLIGHT SEQUENCE PLAN

A. Launch from Atlantic Missile Range (AMR) Launch Pad #37B.

(Launch azimuth - 90°) - (Flight azimuth - 105°).

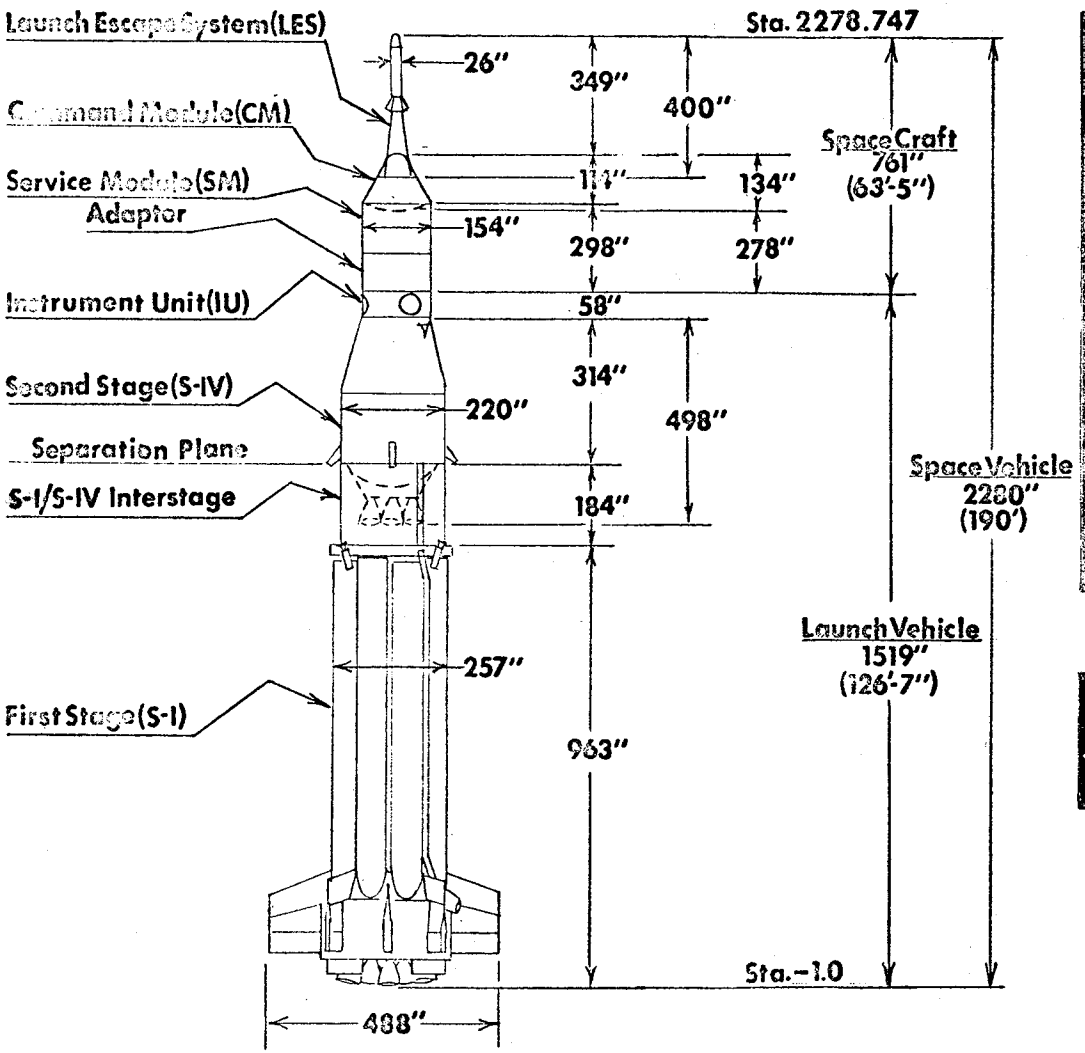
1. S-I ignition and thrust build up to 1,500,000 lbs.
2. Space Vehicle (SV) vertical lift-off and maneuver to 105° flight azimuth.
3. S-I cut-off sequence.
4. S-I - Coast.
5. S-IV ullage rockets fire.
6. S-I/S-IV separation signal, explosive bolts and S-I retro rockets fire.
7. S-IV ignition.
8. S-IV thrust phase.
9. Launch Escape Tower jettison signal at ten seconds after S-IV ignition.

10. Launch Escape Tower jettison motor ignition and Launch Escape Tower jettison.
11. S-IV injection of BP #13 into 100 NM circular orbit. No separation from S-IV.
12. Orbital position determination.
13. Required staytime in orbit for mission accomplishment _____.
14. Estimated staytime in orbit, or;
15. Disposition of orbital hardware _____.
16. No earth recovery.

SA-6

SPACE VEHICLE CONFIGURATION

Launch Vehicle - - - - - - - - - - - - - - SA-6
Stage 1 - - - - - - - - - - - - - - - - - S-I-6 (Live)
Stage 2 - - - - - - - - - - - - - - - - - S-IV-6 (Live)
Instrument Unit - - - - - - - - - - - - S-IU-6
Spacecraft - - - - - - - - - - - - - - - Boilerplate (BP-13)
S IU/SC Interstage - - - - - - - - - - Adapter
Service Module (SM) - - - - - - - - - BP
Command Module (CM) - - - - - - BP
Launch Escape System (LES) - - - - - - Partial



WEIGHTS
(lbs.)

	DRY	SV IGNITION
Launch Escape System	6,600	6,600
Command Module	5,710	5,710
Service Module	4,550	4,550
Adapter	2,100	2,100
Ballast	6,240	6,240
Space Craft(SC) (sub-total)	25,200	25,200
PAYLOAD(P/L) (SC less LES)	18,600	--
Instrument Unit	4,850	4,850
S-IV	11,978	114,382
S-I/S-IV Interstage	1,888	1,888
S-I	103,000	994,714
Launch Vehicle(LV) (sub-total)	121,716	15,834
Space Vehicle(SV) TOTAL	146,916	1,141,034

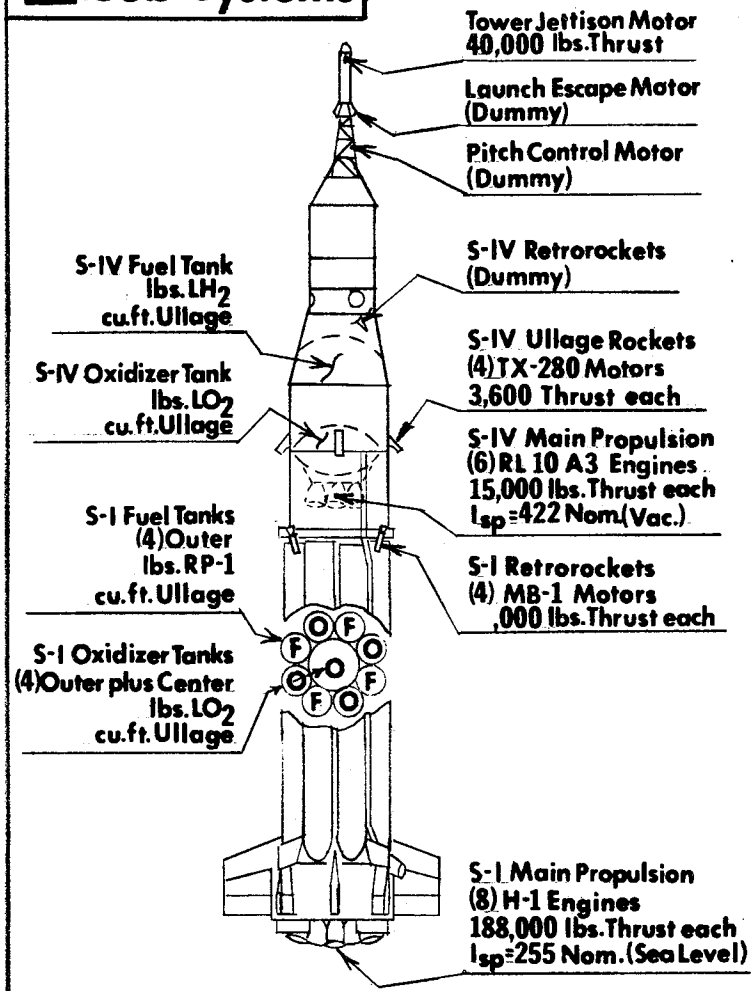
SPACE VEHICLE P/L CAPABILITY

INJECTION	PAYLOAD(lbs)
100 NM Circular Orbit	18,626

LAUNCH VEHICLE SA-6
AND BP #13

SPACE VEHICLE PHYSICAL CHARACTERISTICS

IV Sub-Systems



Typical SV Propulsion Sequence

Time(sec.)	Event
-3.4	Ignition command, engine 5 & 7 ignite
-3.3	Engines 6 & 8 ignite
-3.2	Engines 2 & 4 ignite
-3.1	Engines 1 & 3 ignite
0	Lift off
113.	LH_2 pre-start (35 sec)
132.	S-I stage propellant level sensors armed.
138.	LO_2 pre-start (10 sec)
139.900	Cut-off Engine 5, 6, 7, & 8 (outboard)
145.900	Cut-off Engine 1, 2, 3, & 4 (inboard)
146.190	S-IV ullage rocket firing (3 or 4 sec)
146.300	S-I/S-IV separation command
146.315	Separation devices actuate
146.365	S-I - Retro-rockets fire
148.065	S-IV Engines ignite
149/150	S-IV ullage rockets cut-off
158.065+	Sep devices activated & tower jettison mtr ign.
616±	S-IV Engines burn out
	No SC propulsion

Launch Vehicle Nr. SA-6
Space Craft Nr. BP#13

A. Propulsion

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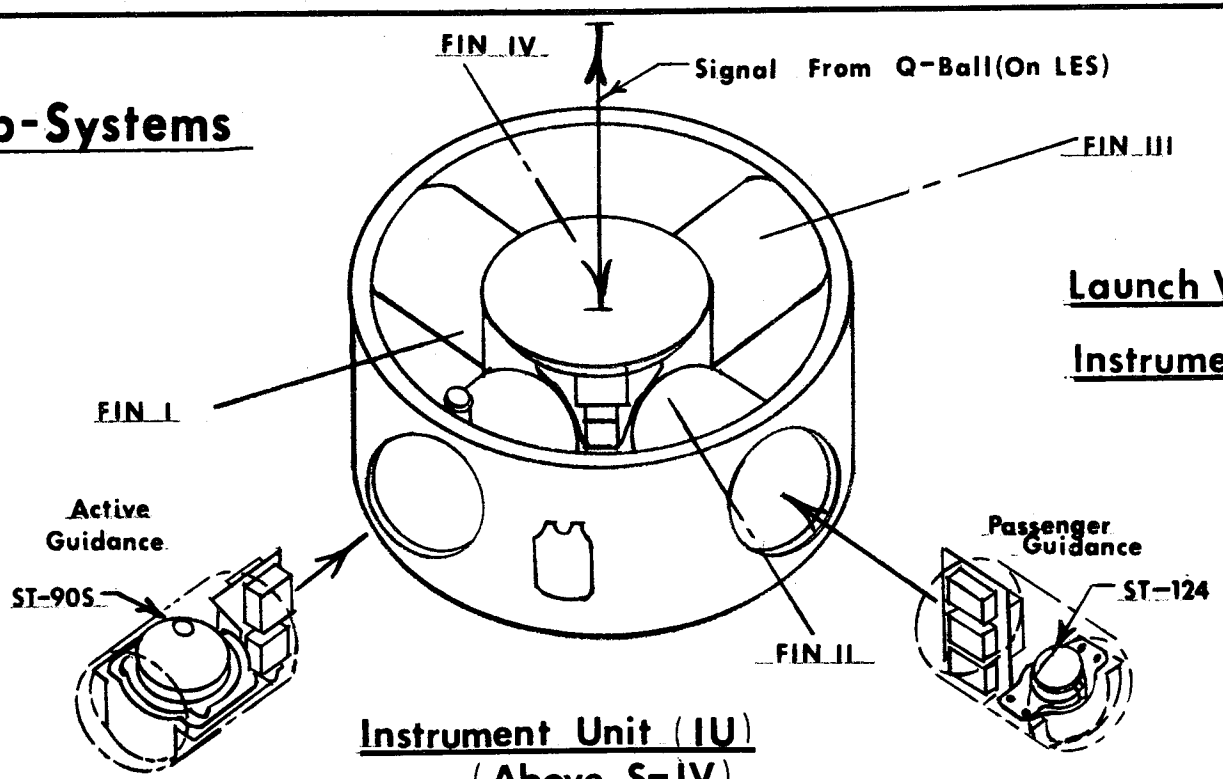
SA-6

PROPULSION TEST OBJECTIVES

1. Determine propellant sloshing characteristics.
2. Verify performance characteristics of:
    a. H-1 Engines (8)
    b. RL-10A-3 Engines (6)
    c. (Separation) Retro rockets
    d. Ullage Rockets
    e. Tower Jettison Motor
3. Verify engine response to programmed propulsion sequence.
4. Verify operating characteristics of:
    a. Hydrogen vent system.
    b. Helium pressurization system.
    c. Helium heat exchanger and gas generator.
5. Determine aerodynamic engine torques.
6. Collect environmental data on propulsion system such as temperatures, pressures, vibrations, etc.

IV Sub-Systems



Launch Vehicle SA-6

Instrument Unit S-IU-6

Instrument Unit (IU)
(Above S-IV)

ACTIVE GUIDANCE
ST-90S Stabilized Platform
Flight Control Computer
Type J Mod 2 Program Device
Control Signal Processor

ASSOCIATED ELEMENTS
Control Accelerometers
Control Rate Gyros
Flight Sequencer & Slave
Horizon Sensor

PASSENGER GUIDANCE
ST-124 Stabilized Platform
GSP-24 Guidance Signal Processor
ASC-15 Guidance Computer

B. GUIDANCE AND CONTROL CONFIGURATION

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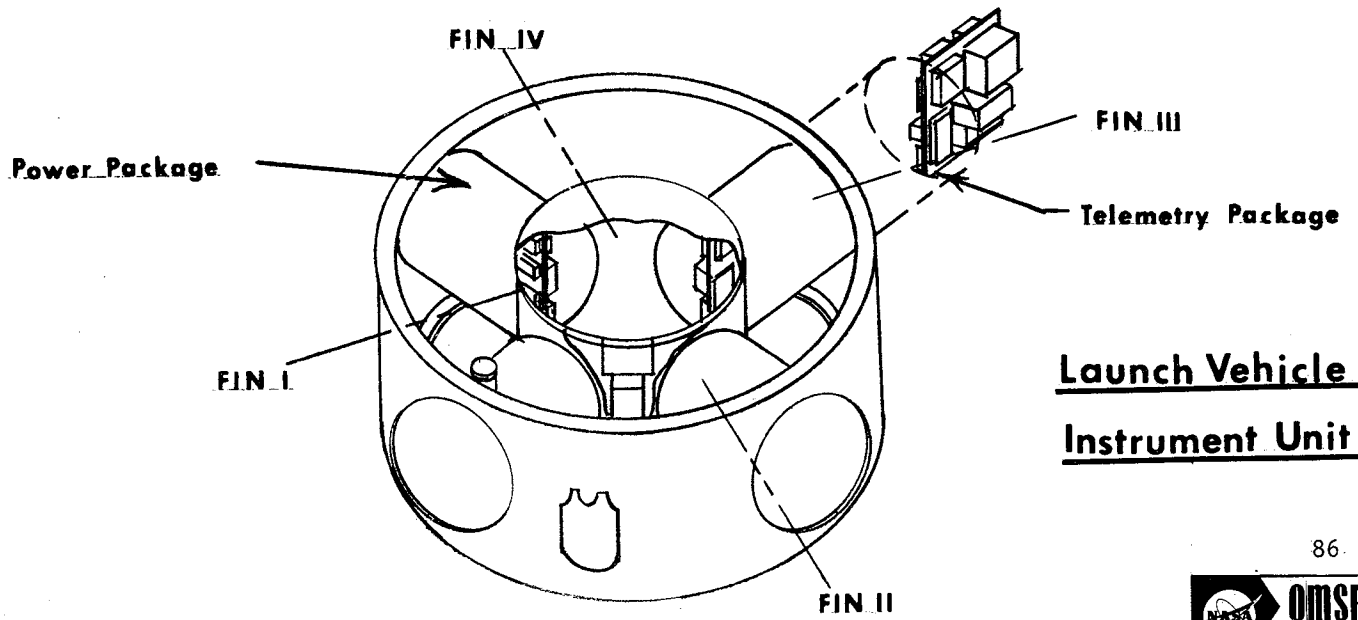
IV B. (con't)

POWER
Batteries (28 Volt)
Static Inverters (115 V, 400 CPS)
Control Voltage Supply (60 V DC)
Power Supply (56 V DC)
Master Measuring Voltage Supply (5 V DC)

TELEMETRY	
XO-4	PAM/FM/FM
XO-4B	PAM/FM/FM
XO-7	PAM/SS/FM

TRACKING
Azusa
C-Band Radar
UDOP
ODOP
Mistram
Radar Altimeter



Launch Vehicle SA-6

Instrument Unit S-IU-6

POWER, TELEMETRY & TRACKING CONFIGURATIONS

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NO. REV.
DATE Feb 8, 63 REF. Goldston

SA-6

B. GUIDANCE AND CONTROL, INSTRUMENTATION, AND TRACKING TEST OBJECTIVES

1. To evaluate passenger and developmental items under operational conditions.

2.* To evaluate G&C systems performance on first flight of LV with simulated spacecraft.

3. Demonstrate spacecraft and IU connection methods;

   (a) Electrical

   (b) Mechanical

4. Evaluate cable mounting techniques.

5. Monitor by recoverable movie cameras;

   (a) Sloshing

   (b) Inter-stage chill-down and separation.

   (c) Ullage and retro-rocket operation

SA-6

6. Monitor by television coverage

   (a) Operation of ullage rockets.

7. Monitor emergency detection sensors.

8. Determine launch and exit spacecraft environmental criteria (CM instrumentation).

9. Verify operational suitability of on-board tracking system.

10. Determine feasibility of an up-dating system for guidance computer.

11. Determine optimum locations for control accelerometers and gyros.

12. Evaluate power system.

V. FLIGHT OPERATIONS PLAN

NOTE: It is felt that a plan should be included highlighting the events of launch and in-flight with the major objectives relative to this operation. Listed below are some considerations for content.

A. Vehicle assembly and preflight checkout (schedule of significant events and responsibilities, etc.)

B. Countdown (significant phases).

1. Systems flight readiness verification.

2. Propellant loading, etc.

3. Holds, (repair and maintenance levels).

C. Launch phase.

1. Range safety.

2. Tracking (ground station, etc.)

3. Evaluation objectives for Crew Safety during launch operations such as evaluating critical phases to be monitored in subsequent manned flights, etc.

D. Tracking during boost phase.

   1. Data acquisition (recording, etc.).

   2. Ground command decisions and flight control (responsibilities).

   3. Data reduction and dissemination.

E. Orbital data collection.

F. Integrated Flight Evaluation Plan (for evaluation of Launch Complex System as well as flight vehicle performance).

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